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(54) [Title of the Invention] TFT Liquid Crystal Display Device

(57) [Abstract]

[Object]

To provide a liquid crystal display device in which an outgoing wiring part of a source/drain electrode provided in a peripheral part of a liquid crystal display panel is not peeled to be a wiring defect at a time of cracking the liquid crystal display panel.

[Solving means]

In a thin film transistor array of a TFT liquid crystal display device, at least at part of a base of an outgoing wiring part 10a of a source/drain electrode, a gate insulating film 5 and a semiconductor film 6 which are lower layers thereof are removed to form a structure having a recessed part 12 in a region below a panel cracking part. Thereafter, the outgoing wiring part 10a of the source/drain electrode is formed in the recessed part 12, thereby preventing disconnection due to mechanical stress at a time of cracking the panel.

[Scope of Claims]

[Claim 1]

A TFT liquid crystal display device comprising:

a thin film transistor array in which, over a light-transmitting insulating substrate, a gate insulating film and a semiconductor film are formed and a source/drain electrode is formed to intersect with a transparent pixel electrode and a gate electrode,

wherein a recessed part is formed by removing the gate insulating film and the semiconductor film beneath an outgoing wiring part of the source/drain electrode, and

wherein the outgoing wiring part of the source/drain electrode is formed so that part of the outgoing wiring part of the source/drain electrode is at least in contact with the light-transmitting insulating substrate in the recessed part.

[Claim 2]

The TFT liquid crystal display device as described in claim 1, wherein the recessed part is provided in a position corresponding to a cracking part at a time of cracking a liquid crystal panel.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention belongs to]

The present invention relates to a liquid crystal display device, in particular, an

outgoing wiring part of a source/drain electrode of a TFT array in a TFT (thin film transistor) liquid crystal display device.

[0002]

[Related Art]

Conventionally, for a gate electrode of a TFT liquid crystal display device, a metal conductive film such as aluminum, chromium, or tantalum is used. Further, for a source/drain electrode, a metal conductive film such as aluminum, titanium, or molybdenum is used. On the other hand, in a TFT liquid crystal display device as a computer terminal, high definition, high response speed, and high visibility are required, and particularly, high luminance without image flickering is desired. In order to respond to this requirement, a picture element area has to be increased, and the wiring width of the gate electrode and the source/drain electrode has to be narrowed. However, when the wiring width of the gate electrode and the source/drain electrode is narrowed to deal with the above situation, a wiring defect due to disconnection of the gate electrode and the source electrode is generated, which lowers the yield of the TFT array.

[0003]

FIG. 2 shows an in-plane wiring pattern of a TFT array of a TFT liquid crystal display device, and FIG. 3 is a cross-sectional view in the case where FIG. 2 is sectioned along a line A-A'. In addition, FIG. 4 shows a cross-sectional view in the case where FIG. 2 is sectioned along a line B-B' in the in-plane wiring pattern of the TFT array of the conventional TFT liquid crystal display device.

[0004]

In FIG. 2 to FIG. 4, reference numeral 1 denotes a light-transmitting insulating substrate such as glass, 2 denotes a pixel electrode such as indium oxide containing tin oxide, 3 denotes an insulating film such as a silicon oxide film formed to cover the pixel electrode 2, 4 denotes a gate electrode such as aluminum formed by a sputtering method or the like, 5 denotes a gate insulating film such as silicon nitride, 6 denotes an intrinsic semiconductor layer such as undoped hydrogenated amorphous silicon, 7 denotes a semiconductor protecting layer formed into an island shape, 8 denotes an ohmic contact

layer such as amorphous silicon hydride doped with phosphorus or the like, 9 denotes a contact hole which electrically connects the pixel electrode 2 and a drain electrode 11, and 10 denotes a source electrode.

[0005]

As shown in FIG. 4, in the TFT array of the conventional TFT liquid crystal display device, the peripheral outgoing wiring part 10a of the source/drain electrode is formed over a multilayer film including the gate insulating film 5, the intrinsic semiconductor layer 6, and the ohmic contact layer 8.

[0006]

By the way, in such a TFT liquid crystal display device, a defect part may be generated in the outer edge of the manufactured display device; therefore, the outer edge is cracked and removed after manufacturing. Alternatively, in order to reduce the manufacturing cost, a plurality of TFT arrays are manufactured in the integral manner and combined with a color filter over a counter substrate, and thereafter, the panel is cracked so as to correspond to each TFT array.

[0007]

[Problems to be solved by the Invention]

However, in the conventional TFT liquid crystal display device, after the TFT array is combined with the color filter over the counter substrate, the outgoing wiring part 10a in the panel cracking line x part is peeled from the intrinsic semiconductor layer 6 where adhesion is low due to influence of external stress which is caused by mechanical stress applied at a time of cracking, thereby causing a wiring defect. Accordingly, imaging performance is lowered when the conventional TFT liquid crystal display device displays an image as a liquid crystal display panel.

[0008]

The present invention solves the above problems, and the object is to provide a liquid crystal display device in which an outgoing wiring part of a source/drain electrode provided in a peripheral part of a liquid crystal display panel is not peeled to be a wiring defect at a time of cracking the liquid crystal display panel.

[0009]

[Means for solving the Problems]

In order to solve the above problems, the present invention provides a TFT liquid crystal display device including a thin film transistor array in which, over a light-transmitting insulating substrate, a gate insulating film and a semiconductor film are formed and a source/drain electrode is formed to intersect with a transparent pixel electrode and a gate electrode, where a recessed part is formed by removing the gate insulating film and the semiconductor film beneath an outgoing wiring part of the source/drain electrode, and the outgoing wiring part of the source/drain electrode is formed so that part of the outgoing wiring part of the source/drain electrode is at least in contact with the light-transmitting insulating substrate in the recessed part.

[0010]

According to the present invention, it is possible to obtain a liquid crystal display device in which an outgoing wiring part of a source/drain electrode provided in a peripheral part of a liquid crystal display panel is not peeled to be a wiring defect at a time of cracking the liquid crystal display panel.

[0011]

[Embodiment Mode of the Invention]

According to the invention as described in claim 1 of the present invention, in a TFT liquid crystal display device including a thin film transistor array in which, over a light-transmitting insulating substrate, a gate insulating film and a semiconductor film are formed and a source/drain electrode is formed to intersect with a transparent pixel electrode and a gate electrode, a recessed part is formed by removing the gate insulating film and the semiconductor film beneath an outgoing wiring part of the source/drain electrode, and the outgoing wiring part of the source/drain electrode is formed so that part of the outgoing wiring part of the source/drain electrode is at least in contact with the light-transmitting insulating substrate in the recessed part. By this structure, part of the outgoing wiring part of the source/drain electrode is formed over the light-transmitting insulating substrate with high adhesion. Therefore, even when mechanical stress is applied at a time of cracking the liquid crystal display panel, the outgoing wiring part of the source/drain electrode is prevented from peeling.

[0012]

According to the invention as described in claim 2 of the present invention, a recessed part is provided in a position corresponding to a cracking part at a time of cracking a liquid crystal panel. By this structure, the recessed part is provided particularly in a position corresponding to the cracking part at a time of cracking the liquid crystal panel, and the outgoing wiring part of the source/drain electrode is formed so as to be in contact with the light-transmitting insulating substrate at this position. Therefore, adhesion can be ensured particularly at the point where mechanical stress is applied at a time of cracking the liquid crystal display panel, thereby preventing the outgoing wiring part of the source/drain electrode from peeling.

[0013]

Hereinafter, an embodiment mode of the present invention will be described with reference to FIG. 1 to FIG. 3. Note that FIG. 2 shows an in-plane wiring pattern of a TFT array of a TFT liquid crystal display device, and FIG. 3 is a cross-sectional view in the case where FIG. 2 is sectioned along a line A-A'. Parts shown in these drawings are the same as those in the conventional TFT liquid crystal display device. On the other hand, FIG. 1 is a cross-sectional view of a TFT liquid crystal display device according to the embodiment mode of the present invention and corresponds to a cross-sectional view in the case where FIG. 2 is sectioned along a line B-B'. Note that parts having the same functions as those of the conventional one will be explained by using the same reference numerals.

[0014]

A TFT array of this TFT liquid crystal display device is manufactured as follows. First, a transparent conductive film (not shown in the drawing) such as indium oxide containing tin oxide is formed over a light-transmitting insulating substrate 1 such as glass by a sputtering method or the like. Thereafter, a pixel electrode 2 is formed by a method such as photolithography. Then, an insulating film 3 such as a silicon oxide film is formed to cover the pixel electrode 2 by a normal pressure chemical vapor deposition method or the like. Thereafter, a metal film such as aluminum is formed by a sputtering method or the like to form a gate electrode 4.

Subsequently, over the gate electrode 4, a gate insulating film 5 is formed using an anodized film, a silicon nitride film formed by a chemical vapor deposition method, or the like. Furthermore, an intrinsic semiconductor layer 6 such as undoped hydrogenated amorphous silicon, a silicon nitride film which is a semiconductor protecting layer 7 having a sufficient selective ratio to the intrinsic semiconductor layer 6, and the like are preferably formed by a plasma CVD method, continuously.

[0015]

Subsequently, the semiconductor protecting layer 7 is formed into an island-shape at least in a TFT channel part, and thereafter, an ohmic contact layer 8 is formed using amorphous silicon hydride doped with phosphorus or the like by a plasma CVD method or the like. Then, a contact hole 9 which electrically connects the pixel electrode 2 and a drain electrode 11 is formed by dry etching or the like.

[0016]

At this time, the ohmic contact layer 8, the intrinsic semiconductor layer 6, the gate insulating film 5, and the insulating film 3 (not shown in FIG. 1) are concurrently removed by a dry etching method or the like, which are beneath an outgoing wiring part 10a, in a peripheral part of a TFT array in a position corresponding to a position, where stress is applied at a time of cracking after the TFT array and a color filter over a counter substrate are combined, i.e. in a cracking line x part. Therefore, a structure having a recessed part 12 in a region intersecting with the panel cracking line x part is obtained. Thereafter, a metal film such as aluminum is formed by a sputtering method or the like in the recessed part 12, and the outgoing wiring part 10a of a source electrode 10 and the drain electrode 11 is formed.

[0017]

In such a manner, in the TFT liquid crystal display device, when the outgoing wiring part 10a of the source/drain electrode in the peripheraly of the TFT array is formed, the gate insulating film 5, the semiconductor layer 6, and the like which are a base are previously removed by dry etching or the like, and a structure having the recessed part 12 in a region intersecting with the panel cracking line x part is obtained. Thereafter, by forming the outgoing wiring part 10a of the source/drain electrode, the

outgoing wiring part 10a of the source/drain electrode is firmly adhered to the light-transmitting insulating substrate 1; therefore, the outgoing wiring part 10a of the source/drain electrode is prevented from peeling even when mechanical stress is applied at a time of cracking the liquid crystal display panel. Accordingly, disconnection due to stress at a time of cracking the panel is prevented; thus, image quality as the liquid crystal display device and the manufacturing yield can be improved.

[0018]

In addition, particularly, the recessed part 12 is provided in a position corresponding to the cracking line x part at a time of cracking the liquid crystal panel, and the outgoing wiring part 10a of the source/drain electrode is formed so as to be in contact with the light-transmitting insulating substrate 1 at that point. Therefore, adhesion particularly at the point where mechanical stress is applied at a time of cracking the liquid crystal display panel is ensured, and it is not required to form an unnecessary recessed part at another point while preventing disconnection due to stress at a time of cracking the panel. Accordingly, steps in manufacturing are not increased more than necessary. In addition, when the contact hole 9 is formed, the gate insulating film 5 and the semiconductor layer 6 which are the base of the peripheral outgoing wiring part 10a are concurrently removed by a dry etching method or the like, thereby preventing steps in manufacturing from increasing.

[0019]

[Effect of the Invention]

As described above, according to the present invention, it is possible to prevent a disconnection defect, which is caused by peeling from the part, where adhesion of a film is low, due to mechanical external stress at a time of cracking a panel. Further, a wiring defect as a liquid crystal display device can be significantly reduced, and image quality and the manufacturing yield can be improved.

[Brief Description of the Drawings]

[FIG. 1] A cross-sectional view of a TFT liquid crystal display device according to the embodiment mode of the present invention, corresponding to a cross-sectional view in the case where FIG. 2 is sectioned along a line B-B'.

[FIG. 2] A plan view showing an in-plane wiring pattern of a TFT array of a TFT liquid crystal display device.

[FIG. 3] A cross-sectional view in the case where FIG. 2 is sectioned along a line A-A'.

[FIG. 4] A cross-sectional view of a conventional TFT liquid crystal display device, corresponding to a cross-sectional view in the case where FIG. 2 is sectioned along a line B-B'.

[Explanation of Reference Numerals]

1	light-transmitting insulating substrate
2	pixel electrode
4	gate electrode
5	gate insulating film
6	intrinsic semiconductor layer
10	source electrode
10a	outgoing electrode part
11	drain electrode
12	recessed part
x	cracking line